Rolling at small scales - DTU Orbit (08/11/2017)

Rolling at small scales

The rolling process is widely used in the metal forming industry and has been so for many years. However, the process has attracted renewed interest as it recently has been adapted to very small scales where conventional plasticity theory cannot accurately predict the material response. It is well-established that gradient effects play a role at the micron scale, and the objective of this study is to demonstrate how strain gradient hardening affects the rolling process. Specifically, the paper addresses how the applied roll torque, roll forces, and the contact conditions are modified by strain gradient plasticity. Metals are known to be stronger when large strain gradients appear over a few microns; hence, the forces involved in the rolling process are expected to increase relatively at these smaller scales. In the present numerical analysis, a steady-state modeling technique that enables convergence without dealing with the transient response period is employed. This allows for a comprehensive parameter study. Coulomb friction, including a stick-slip condition, is used as a first approximation. It is found that length scale effects increase both the forces applied to the roll, the roll torque, and thus the power input to the process. The contact traction is also affected, particularly for sheet thicknesses on the order of 10 μm and below. The influences of the length parameter and the friction coefficient are emphasized, and the results are presented for multiple sheet reductions and roll sizes.

General information

State: Published
Organisations: Department of Mechanical Engineering, Solid Mechanics, Harvard University
Authors: Nielsen, K. L. (Intern), Niordson, C. F. (Intern), Hutchinson, J. W. (Intern)
Number of pages: 10
Publication date: 2016
Main Research Area: Technical/natural sciences

Publication information

Journal: Journal of Manufacturing Science and Engineering
Volume: 138
Issue number: 4
Article number: 041004
ISSN (Print): 1087-1357
Ratings:
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): SJR 1.232 SNIP 1.449 CiteScore 2.68
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 0.754 SNIP 1.148 CiteScore 1.62
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 0.684 SNIP 1.1 CiteScore 0.96
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 0.784 SNIP 1.192 CiteScore 1.2
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 0.685 SNIP 0.942 CiteScore 0.8
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 0.572 SNIP 1.019 CiteScore 0.93
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 0.81 SNIP 1.042
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 0.926 SNIP 1.309
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 0.901 SNIP 1.464

Scopus rating (2007): SJR 1.309 SNIP 1.609
Scopus rating (2006): SJR 0.907 SNIP 1.496
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.288 SNIP 1.722
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 1.228 SNIP 1.35
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 0.924 SNIP 1.486
Scopus rating (2002): SJR 1.174 SNIP 1.799
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 0.901 SNIP 1.706
Scopus rating (2000): SJR 0.822 SNIP 1.375
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 0.785 SNIP 1.732
Original language: English
Foils, Metal forming, Rolling, Size effects
DOIs:
10.1115/1.4031068
Source: FindIt
Source-ID: 2279789751
Publication: Research - peer-review › Journal article – Annual report year: 2015